AEA 92559 – 1: TOWARDS AN ARGENTINEAN SMART GRID VISION

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ABSTRACT

AEA 92559-1 Guide Smart Electrical Grids: Concepts, Benefits and Challenges for Implementation was published in 2013 [1]. This guide is the result of joint work of professionals from the Argentinean electrical industry. It aims to establish the concept of Smart Grid, benefits and obstacles to its implementation in the national grid. The scope, stakeholders, origin, challenges and applicable technologies are conceptually defined. This guide is the first in a series of documents made by Argentinean Electrotechnical Association – Studies Committee 08..

AEA BACKGROUND

AEA (Argentinean Electrotechnical Association, is the reference institution in Argentina in terms of electrical installations, at all voltage levels. It was founded in 1913 and since that time it has represented the country at the IEC (International Electrotechnical Commission).
AEA generates rules and guidelines that are then elevated to the status of mandatory by the argentinean regulatory and government agencies.

INTRODUCTION

The electric grid of the future requires a qualitative leap. Due to the need for better management of energy resources, promote environmental protection and meet the increasingly stringent requirements for service and power quality, the concept called "Smart Grid" arises.
In 2010, AEA realized it was necessary to work on this new front. A Study Committee was formed in order to consensually define the concept of Smart Grid and its application in the country, resulting in AEA 92559-1 Guide Smart Electrical Grids: Concepts, Benefits and Challenges for Implementation. The CE08 (Study Committee 08, is composed by actors across the electricity sector:

<u>Government agencies</u>: National Secretary of Energy, Secretary of Energy of the Province of Santa Fe, CAMMESA (Administrative Company of the Wholesale Electricity Market).

<u>Standardization organizations</u>: IRAM (Argentine Institute of Standardization and Certification, INTI (National Institute of Industrial Technology.
<u>Transmission and distribution utilities.</u>
<u>Equipment and services suppliers.</u>
<u>Educational entities.</u>

SMART GRID DEFINITION

AEA defines Smart Grid as "a combination of the traditional grid with modern information and communication technologies. Smart Grid can integrate data from different points of the electric chain, from the generator to the end user, and transform them into information and actions that lead to improved management. Its aim is to raise the efficiency, reliability, sustainability and quality of service to meet the new challenges of multiple generation and various consumption styles."

CAUSES OF ORIGIN

We can associate the following reasons as behind the development of the Smart Grid:
<u>Economic</u>: increasing dependence on non-renewable energy sources, increased costs of generation and operation.
<u>Productive</u>: greater criticality of electric service in productive processes, and society in general.
<u>Environmental</u>: need to comply with international treaties and greater public interest in reducing greenhouse gases emissions.

EXPECTED OBJECTIVES

A Smart Grid implementation expects to achieve:

<u>Economic Objectives</u>

a- Maximize the use of existing infrastructure, deferring investments.
b- Avoid using less efficient power plants, minimizing peak demand by time-of-use, real time pricing and peak shaving programs.
c- Optimize operating costs by innovative maintenance programs and minimizing need for on-site personnel for operating, reading, fraud control or maintenance, allowing its use in more value-generating tasks.
d- Reduce technical and non-technical losses.

<u>Productive objectives</u>

a- Flexibility to adapt to new or more stringent requirements on service and power quality.
b- Mitigate the effect of electrical installations failures, reducing affected area and time needed to restore the service.
c- Educate and provide tools to the end-user to encourage efficient consumption habits.
d- Establish an appropriate pricing system, allowing the purchase and sale of energy by the user, encouraging the installation of renewable generation.
e- Incentives to attract investment for related industries.
f- Deter possible acts of vandalism.
g- Avoid the continuity of service in facilities after a failure or malfunction which may endanger the lives of those who are near them.

Environmental objectives

a- Reduce greenhouse gases emission.
b- Reduce the environmental impact due to network laying.
c- Diversify energy sources; increasing the share of clean energy and achieving the implementation of distributed generation.

CHALLENGES TO IMPLEMENTATION

Every project involves a set of obstacles that must be overcome for a successful outcome. Considering the various political, social and technological aspects involving a Smart Grid, it was decided to divide the challenges into two sets:

Technical challenges

a- Transition period without loss of reliability: coexistence of equipment and operating procedures for "smart" and "traditional" networks.
b- Communication: use of the most adequate communication.
c- Interoperability and interchangeability.
d- Scalability: upgradeability of systems to adapt to new requirements or set of customers.
e- Cyber security: access protocols and validation measures appropriate to the type of information.
f- Distributed generation and energy storage planning, operation and protection devices coordination.

Non-technical challenges

a- Modification of the rate schedule: implement a pricing system that encourages rational energy use.
b- Investment recovery and repayment.
c- Data privacy
d- Workforce profile change.
e- Resistance to change.

STAKEHOLDERS

Stakeholders can be divided according to the function they fulfill in a Smart Grid structure:

Regulatory framework definition

National, Provincial and Municipal Government

Network management

a- Generating, Transmission and Distribution companies
b- Electric cooperatives
c- Administrative Bodies

Users

a- Residential, Business and Industrial customers
b- Low Income customers
c- Prosumers (consumer + generator)

Consulting and Standardization institutions

a- IRAM, INTI, AEA
b- International organizations such as ISO, IEC and IEEE
c- Universities

Civilians organizations

a- Labor unions
b- Consumer associations

STEPS TO A SUCCESSFUL IMPLEMENTATION

The many factors involved have the practical effect of defining the transition to Smart Grids in response to the weaknesses or objectives of each electrical system. The solutions flexibility allows them to adapt to the needs of each network according, to the infrastructure and the authorities' decisions.
In developed countries, factors such as technical losses reduction, resources optimization, renewables integration, energy efficiency and a peak demand reduction represent the main reasons for adopting a Smart Grid. In developing countries, other factors such as reducing non-technical losses add up due to theft, and increased reliability against power outages. Generally speaking, the decision to implement a Smart Grid will be based on two factors:
a- Infrastructure and grid characteristics: the condition of existing infrastructure and the level of smart growth is a key variable in the definition of the modernization strategy.
b- Key strategic objectives: are subject to vary, being a reflection of the different challenges and ambitions of each government or utility.
Jumping to a Smart Grid can be done via different projects such as remote metering, remote supervision or remote control. By implementing these technologies, the transition to the Smart Grid REI has begun.

CE08 FUTURE WORK

CE08 is working on a second document, derived from experiences in smart grids. It aims to serve as a guide that provides a common language and framework for defining key elements of smart grid transformation and helping utilities develop a programmatic approach and track their progress.
The guide, in form of a matrix, will be composed of eight domains and six maturity levels. Each domain is a logical group of Smart Grid related characteristics. The levels of maturity represent defined stages, described in terms of organizational capabilities. Level 0 means the start point and 5, pioneering.
The work is based on the Smart Grid Maturity Model from the Software Engineering Institute, Carnegie-Mellon University [2]. SEI is a federally funded research and development center that is an international leader in the development and application of capability models. This guide will be published during 2016.

SMART GRID IMPLEMENTATION IN ARGENTINA

The Argentine Electricity Market is the third energy market in Latin America [3]. It is a regulated market, characterized by the coexistence of generation, transmission and distribution private, privatized and state owned. Also, given Argentina's large territory, there are plenty of utility cooperatives in charge of local distribution, but subject to the provisions of the regional distributor.

Beginning steps

The first step in smarter grid technologies occurred during the 80's, with the introduction of early computers and communication media, especially fixed telephone line, and the development of PLC. From this period dates the first automation and remote control, being used in power plants and transmission and subtransmission stations.
At the same time, need arise for real-time grid status, in particular the load flowing through it. During the first half of the 90's, thanks to the introduction of fully electronic energy meters, CAMMESA, the market administrator body, began implementing the SMED (Demand Measurement System), and SMEC (Commercial Measurement System). The SMED monitors energy demand evaluating whether or not it has reserve. To do this, a certain amount of large industrial users are remote metered, recording the demand curve every 15 minutes. The SMEC measure, record, transmit and process nationwide records that are used by members of the wholesale electricity market to purchase energy, through 2,600 meters.
Also in the 90's, an ambitious automation and communications project was implemented for the installation of power system stabilizers and automatic generation disconnection in generating plants; and automatic load shedding along the National Interconnected Grid, thus ensuring network stability and allowing an increased transmission limit for Extra HV lines.

Current situation

Today, thanks to the massification of IT and telecommunication technologies, there is a wide range of implementations in Argentina. However, many of these are driven by the particular needs of each utility.
Because of their criticality, projects for monitoring and control are common in transmission networks and major utilities. In general, all of them have their HV/MV substations remote monitored and controlled with various levels of automation. However, there are not any projects involving self-healing capabilities. There is a broad consensus in presenting the operator as much information as possible, but letting him decide the restoration procedure. Common communication protocols are IEC 60870-5-101, IEC 60870-5-104 and DNP3.0, with Modbus and legacy protocols slowly declining. IEC 61850 pilot tests are in development stages.
In large urban centers, such as the metropolitan area of Buenos Aires and Córdoba, utilities have implemented remote monitoring of the MV network to support outage restoration. It encompass a series of sensors (e.g. fault current indicator, flooding indicator, LV measurements) connected to a remote terminal unit, reporting to a SCADA. In order to further minimize service restoration times, major utilities are installing MV network remote control systems.

Another front on which progress has been made is the residential and industrial metering. Here, paradoxically, the greatest advances are done by utilities and cooperatives which provide services in rural and widely dispersed areas. The existence of solution providers and access to fixed or mobile telephone networks and other communication technologies allowed the installation of advanced metering infrastructures. The key goals are to prevent the movement of personnel and facilitate reading in areas of difficult access or unsecure conditions. Regulatory bodies do not allow load balance or load remote control programs for residential and commercial customers.

Argentina – DoE cooperation

In April 2010 the Federal Planning, Public Investment and Services Ministry signed a Memorandum of Understanding with the USA Department of Energy; focused on cooperation in clean energy. In this context the Argentina Binational Working Group (BEWG) was established [4]. It has 4 sub-groups:
a- Renewable energy, with special emphasis on forecasts and integration of wind power into the grid.
b- Shale Gas extraction and processing.
c- Nuclear energy applications for civilian uses.
d- Smart power grids.
The Smart Grid sub-group established a working group with the Secretariat of Energy, CAMMESA, ADEERA and INTI to study all the issues related to Smart Grids. During September 2012, a seminar under the BEWG was organized "Present situation and perspectives in Argentina and the US". The seminar had Steven Chu, then US Secretary of Energy, as a keynote speaker.
Finally, in September 2013, a conference was organized with the visit of Dr. Ing. Marcelo Elizondo, from the Pacific Northwest National Laboratory (PNNL). He is a specialist in smart grids and power systems.
As of August 2015, no other events were organized. However, the BEWG is still active in the Shale Gas front.

Armstrong Smart City

In late 2012, at the initiative of the Secretariat of Energy and supported by several international experiences, a study for an integrator pilot project began [4].
The main lines of work were:
a- Develop experiences in planning, installation, operation and maintenance of a smart electrical grid.
b- Promote integration of renewable energy.
c- Try, compare and develop various technologies.
d- Develop experiences to lay groundwork for new regulations.
e- Measure technical-economic impact in regard to optimization of resources, network management, reducing losses and restoring service.
f- Measure social impact, customer satisfaction, outage management, residential load management and low power distributed generation.
The city of Armstrong (Santa Fe), was defined as the first project site. Figure 1 shows the test zones.

To develop this pilot project, the Secretariat of Energy worked along with the Ministry of Science and Technology, and the Agency for Scientific and Technological Promotion, with contributions from the Inter-American Development Bank and the World Bank.

Figure 1 - City of Armstrong.

The project is divided into two stages. The first is the application of mature technologies: remote monitoring and control of the MV, LV distribution networks and an advanced metering infrastructure in residential, commercial and industrial levels. The second phase includes renewable generation, energy efficiency programs and integral grid management.

The first steps consisted in a tender offer for the acquisition of 1,000 smart meters and the development of standard interfaces between the head-end AMI software and the existing commercial/billing software. Four meter vendors where selected, supplying 250 meters and 1 concentrator each.

Explicitly, a mix of communication technologies between concentrator and meters were selected. One vendor provided an RF solution, while the others are PLC.

The communication between concentrators and head-end software is done by optical fiber. It is worth mentioning that the Cooperative also provides communication services to the city.

Another 20 meters will be installed at industrial and rural customers and linked to the head-end software via point-to-point GPRS modems. As per August 2015, the installation of smart meters and the corresponding AMI systems is completed [5].

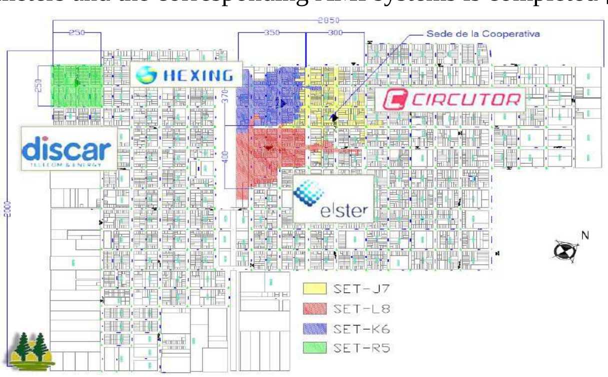

Figure 2 - Map of smart meters installation and vendors.

Work is now in progress to acquire the necessary equipment to enable grid monitoring and telecontrol. Another tender offer was closed recently for the acquisition of MV reclosers, sectionalizers, and fault current indicators. The purpose is to telecontrol the main 33/13.2 kV station and switchgear equipment in rural areas; and supervise distribution substations and future distributed generators. Communication to the Control Center will be done by optical fiber and GPRS modems. New and existing switchgear equipment will be reporting to an up-to-date SCADA software.

In parallel, progress has been made with the Second Stage, with funds approved for the installation of photovoltaic (PV) distributed generation. A 1.5kW PV generator was installed on the Cooperative's roof, under EPE Resolución [6] enabling the connection of generation sources from renewable energy in networks of low and medium voltage. Also, a 50 kW hydrokinetic turbine installation is in study.

Distributed generation

While Argentina is betting on the future use of renewable generation, penetration in the energy matrix is very small and all projects based on wind, solar or biomass plants are connected to the wholesale electricity market.

Recently, efforts have started to generate technical rules and regulation for the connection of renewable generation directly to the LV distribution network. The province of Santa Fe [6] was the first to enable customer-based, low power generation. Provinces of Mendoza [7] and Salta [8] promptly followed. Others are in developing similar proposals. On the technical side, AEA has two working groups on the subject:

a- GT-10G "Energy Efficiency". Currently adapting IEC 60364-8-2 *Smart Low-Voltage Electrical Installations* (Draft)

b- GT-10H "Photovoltaic Panels". AEA 90364-7-712 *Power Supply Systems by Photovoltaic Panels* technical rule.

Other technologies

AEA is working on the electric vehicles subject, creating the new group GT-10I "Supply Facilities for Electric Vehicles"

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